Course Type	Course Code	Name of the Course	L	T	P	Credits
DP	NECC519	**Optimization and Machine Learning Lab**	0	0	3	1.5

Course Objective
To understand optimization techniques and their usage in machine learning.
Learning Outcomes
Upon successful completion of the lab, students will: • be able to simulate unconstrained and constrained optimization techniques. • be able to implement machine learning models utilizing optimization techniques.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Simulation of Fibonacci, Bisection and Secant methods	3	Understanding basic methods for unconstrained optimization
2	Simulation of vanilla, projected and stochastic Gradient Descent (GD, PGD, SGD)	3	Understanding vanilla GD, PGD and SGD algorithms
3	Simulation of Kaczmarz's method	3	Understanding Kaczmarz's method for least squares optimization
4	Simulation of Newton's method	3	Understanding Newton's method for unconstrained optimization
5	Simulation of Nesterov's Accelerated Gradient Descent	3	Understanding Nesterov's accelerated gradient descent
6	Simulation of Conditional Gradient/Frank-Wolfe (FW) method	3	Understanding projection-free FW method
7	Simulation of vanilla and stochastic Iterated Hard Thresholding	6	Understanding implementation of vanilla IHT and StoIHT for sparsity constrained linear systems
8	Implementation of regression models	6	Understanding implementation of linear, polynomial and logistic regression models
9	Implementation of binary classification using SVM and neural networks with SGD	6	Understanding implementation of binary classifiers using SVM and neural networks using gradient descent
10	Density estimation using GMM and EM	6	Implementing EM for estimating GMM
	Total	**42**	

Text Books:

1. Boyd, Stephen and Vandenberghe , Lieven, *Convex Optimization*, Cambridge University Press, 2004.
2. Jain , Prateek and Kar, Purushottam, *Non-convex optimization for Machine Learning*, NOW publishers, 2017.
3. Bishop M., Christopher, *Pattern Recognition And Machine Learning*, Springer (India) Private Limited, 2013.

Reference Books:

1. Nesterov, Yuri, *Lectures on Convex Optimization*, Springer, 2018.
2. Bubeck, Sebastian, *Convex Optimization: Algorithms and Complexity*, NOW publishers, 2015.